Appendix A

METHODOLOGIES FOR FORECASTING ENPLANED PASSENGERS

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This appendix documents the methodologies used to forecast domestic and international enplaned passengers at Tucson International Airport.

DOMESTIC PASSENGERS

The methodology used to prepare annual forecasts of domestic passenger demand at the Airport is based on a growth formula determined by regression analysis. The results obtained by the regression analysis were evaluated with regard to the key factors discussed in the report—many of which cannot be adequately modeled—to ensure that the results were consistent with supplemental data and assumptions. The regression analysis was performed to identify statistically significant relationships between (1) the number of enplaned passengers at Tucson International Airport and (2) indicators of local economic growth and regional fare trends. In regression analyses, the relationship between the dependent variable and the independent variables is mathematically determined, with statistical models specified to "fit" various equations to the data. A number of statistical and logical tests are conducted to compare the models and select the best model. The selected equation is then used to generate forecasts or understand relationships.

In this analysis, the number of enplaned passengers at the Airport was defined as the dependent variable. The following independent variables were considered:

- Population in Pima County
- Total employment in Pima County
- Real personal income (1982-1984 dollars) in Pima County
- The difference in real average airline fares (1982-1984 dollars) between the Airport and Phoenix Sky Harbor International Airport.

Regressions of long-term historical data (1975 through 1994) and short-term data (1986 through 1994) were used to evaluate the recent trends in enplaned passengers at the Airport, particularly with respect to the variation in average airline fares. Historical annual data for average airline fares were available only for 1986 through 1994.

Table A-1 presents the selected long-term and short-term forecasting models. Of the long-term models examined (for the forecast period through 2015), the model having the most desirable statistical properties and the best ability to explain the

Table A-1

REGRESSION ANALYSIS
Tucson International Airport

Long-term model

Selected model: EPAX=-332,687 + 0.214645(INC)

R-squared statistic = 88.0%

Standard error of INC coefficient = 0.18689

Number of observations = 20

Dependent variable = EPAX: Number of annual enplaned passengers at Tucson International Airport

Independent variable = INC: Total personal income in Pima County (in thousands), in constant 1982-1984 dollars. Data obtained from the U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, as reported in the Regional Economic Information System.

Short-term model

Selected model: EPAX = 919,040 + 0.104696(INC) + -14,022.7(FAREDIF)

R-squared statistic = 87.9%

Standard error of INC coefficient = 0.05051

Standard error of FAREDIF coefficient = 2,163

Number of observations = 9

Dependent variable = EPAX: Number of annual enplaned passengers at Tucson International Airport

Independent variables = INC: Total personal income in Pima County (in thousands), in constant 1982-1984 dollars. Data obtained from the U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, as reported in the Regional Economic Information System.

FAREDIF: The difference between the average one-way fares from Tucson and Phoenix, obtained from the U.S. Department of Transportation/Air Transport Association of America, *Origin-Destination Survey of Airline Passenger Traffic, Domestic*, as reported by Data Base Products, Inc. The numbers used represents a 10% sample of the average fares of revenue passengers, to all markets served from each respective base.

Source: Leigh Fisher Associates, July 1995.

historical trend in the number of enplaned passengers at the Airport was the one with real personal income for Pima County (in constant dollars) as the independent variable.

Of the short-term models examined (short term was defined as the next 5 years), the model with total personal income in Pima County and the difference (in constant dollars) between the average fares at Tucson International Airport and Phoenix Sky Harbor International Airport as the independent variables best fit the historical data. The latter variable was examined to determine if lower fares to and from Phoenix correlated with fewer enplaned passengers at Tucson International Airport. From 9 years of data (1986 through 1994), the regression results showed a positive correlation between income and enplaned passengers, as expected, and a negative correlation between the fare differential variable and enplaned passengers, also as expected. Table 3-2 presents the historical data for the selected variables.

Various statistical analyses were used to evaluate the models. The R-squared statistic is a measure of the proportion of the variation in enplaned passengers that can be explained by the variation in independent variables. In the selected models, approximately 88% of the variation in enplaned passengers can be explained by the combined variation in real personal income and difference in real average fares. In addition, the t-statistics reported for the coefficient values allowed the conclusion that, with about 95% confidence, the individual independent variables are significant predictors (i.e., significantly different from zero) of enplaned passengers in the region. The coefficients attached to the independent variables are interpreted as the change in the dependent variable for every one unit increase in the independent variable.

Both of these models were considered for forecasting purposes, although the long-term model was considered as the primary input because (1) it was assumed that, in the future, the difference in average airfares between Tucson and Phoenix would not change significantly and (2) the historical income data used to calibrate the long-term model made the model more appropriate for the long-term forecast analysis.

In addition, alternative forecasts of personal income were used as inputs to the long-term model to derive the high and low forecasts of domestic passenger demand. Table 3A-3 presents forecast domestic enplaned passengers and projected income and fare data used in the selected model.

INTERNATIONAL PASSENGERS

Forecasting international passenger demand at the Airport presents a unique challenge because (1) the historical data are limited, as scheduled international service to Mexico by more than one airline has only developed in the past 2 years, (2) the future role the Airport will play in serving Mexico is unclear given the service developing at other airports in the southwestern United States, such as those in Phoenix, Los Angeles, and

Table A-2

HISTORICAL REGRESSION ANALYSIS DATA
Tucson International Airport

Year	Enplaned passengers	Total income	Difference between fares at Tucson and Phoenix
1976	665,240	4,698,453	n.a.
1977	704,087	4,912,083	n.a.
1978	843,001	5,274,607	n.a.
1979	976,720	5,643,679	n.a.
1980	886,749	5,775,938	n.a.
1981	845,375	6,015,311	n.a.
1982	899,536	5,970,841	n.a.
1983	1,009,681	6,309,593	n.a.
1984	1,054,289	6,629,044	n.a.
1985	1,228,701	7,047,077	n.a.
1986	1,425,149	7,530,328	$14.60
1987	1,576,439	7,696,261	15.47
1988	1,435,825	7,791,082	20.41
1989	1,364,869	7,926,741	28.75
1990	1,333,292	7,786,091	32.31
1991	1,221,546	7,909,561	38.58
1992	1,252,251	8,168,237	32.75
1993	1,305,125	8,437,788	33.85
1994	1,638,342	8,792,176	15.80

n.a. = not available.

Sources: Enplaned passengers: Tucson Airport Authority records

Total income: U.S. Department of Commerce, Bureau of Economic Analysis, as reported on CD-ROM database. Constant dollar adjustment of data are based on the Consumer Price Index published by the U.S. Department of Labor, Bureau of Labor Statistics.

Fares: U.S. Department of Transportation/Air Transport Association of America, *Origin-Destination Survey of Airline Passenger Traffic, Domestic.*

Table A-3

PROJECTED INDEPENDENT VARIABLES AND LONG-TERM MODEL RESULTS

	Total income (in thousands)			Difference between fares at Tucson and Phoenix	Model results Enplaned domestic passengers		
	Base	High	Low		Base	High	Low
1995	$ 9,229	$ 9,564	$ 8,822	$10.00	1,701,487	1,740,324	1,671,588
1996	9,612	10,080	9,051	5.00	1,810,298	1,865,302	1,747,448
1997	10,012	10,625	9,287	--	1,920,880	1,991,184	1,828,393
1998	10,428	11,198	9,528	--	2,026,825	2,129,019	1,885,455
1999	10,861	11,803	9,776	--	2,125,730	2,262,455	1,944,001
2000	11,312	12,441	10,030	--	2,228,744	2,403,095	2,004,068
2001	11,639	12,988	10,251	n.a.	2,303,307	2,523,880	2,056,217
2002	11,975	13,559	10,476	n.a.	2,380,022	2,649,979	2,109,512
2003	12,320	14,156	10,706	n.a.	2,458,953	2,765,726	2,151,323
2004	12,676	14,779	10,942	n.a.	2,540,162	2,885,786	2,193,755
2005	13,042	15,429	11,183	n.a.	2,621,683	3,008,880	2,234,187
2006	13,357	15,969	11,395	n.a.	2,693,629	3,125,951	2,283,467
2007	13,680	16,528	11,612	n.a.	2,767,315	3,247,120	2,333,683
2008	14,011	17,107	11,832	n.a.	2,842,783	3,372,529	2,384,854
2009	14,350	17,705	12,057	n.a.	2,920,075	3,502,328	2,425,072
2010	14,697	18,325	12,286	n.a.	2,999,237	3,636,670	2,465,820
2011	15,052	18,966	12,520	n.a.	3,080,312	3,775,714	2,507,105
2012	15,416	19,630	12,758	n.a.	3,163,349	3,919,624	2,548,934
2013	15,789	20,317	13,000	n.a.	3,248,393	4,068,571	2,591,317
2014	16,171	21,028	13,247	n.a.	3,335,494	4,202,389	2,634,260
2015	16,562	21,764	13,499	n.a.	3,422,366	4,327,137	2,669,606

Note: The forecast model results shown in the table were calculated by applying the annual growth rates from the direct regression model results to 1994 base year data.

n.a. = not applicable.

Sources: Total income: National Planning Association, Data Services, Inc., *Key Indicators of County Growth: 1990-2015*, 1994 edition.

Fare difference and enplaned passengers: Leigh Fisher Associates, July 1995.

San Diego, and (3) the recent passage of NAFTA has raised expectations that international business activity, and consequently international passenger demand, will increase significantly over the next 20 years.

A market approach was selected as the most appropriate methodology to develop the international passenger forecasts for the Master Plan Update. In the market approach, international passenger demand at the Airport is forecast in the context of international airline service to and from Tucson. It was assumed that Mexico would be the only international market from which scheduled passenger airline service is offered over the forecast period.

First, specific assumptions were made about the number of additional weekly flights, aircraft seats, and passengers for the Mexico market on a year-by-year basis. These assumptions were developed taking the following factors into consideration:

- Current (1994) international airline service from the Airport in terms of airlines serving the route, number of departures, days of operation, number of seats, equipment type, and number of stops
- The historical development of international airline service to Mexico at other airports in the southwestern United States in terms of airlines serving the route, number of departures, days of operation, number of seats, equipment type, and number of stops
- Forecast economic growth for Tucson and the State of Arizona, including population, employment, and income
- Forecast economic growth for Mexico
- Forecasts of international passenger demand prepared by the FAA, the International Air Transport Association, Boeing, and others

The resulting preliminary international passenger forecast was then validated by expressing international passenger demand at the Airport (1) as an increase from the existing base, (2) as a percentage of forecast national demand, and (3) in relation to socioeconomic data. Informed judgment was used as part of an iterative process to adjust the preliminary passenger forecast based on these alternative ways of expressing demand.

From the market analysis and using the alternative ways of expressing demand, assumptions and conclusions were developed in determining international aviation demand at the Airport. Consistent with the preceding discussion, assumptions and conclusions are not determined independently, but are considered in combination with other factors and assumptions.

Table A-4 presents the specific year-by-year assumptions used to generate the base forecast of international enplaned passengers as well as the alternative high and low forecasts. Trends in the specific year-by-year assumptions for 1995 through 2005 were used to make assumptions for 2015.

Table A-4

INTERNATIONAL PASSENGER FORECAST ASSUMPTIONS

Tucson International Airport
1995-2005

BASE CASE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2015
Jet												
Weekly flights	14	17	19	21	24	26	28	31	33	35	37	54
Daily flights	2.00	2.43	2.71	3.00	3.43	3.69	4.00	4.43	4.71	5.00	5.24	7.78
Annual flights	730	886	991	1,095	1,251	1,345	1,460	1,616	1,721	1,825	1,914	2,839
Annual seats (@131)	95,630	116,122	129,784	143,445	163,937	176,232	191,260	211,752	225,414	239,075	250,687	371,930
Load factor	47.0%	47.5%	48.0%	48.5%	49.0%	49.5%	50.0%	50.5%	51.0%	51.5%	52.0%	57.0%
Enplanements	44,946	55,158	62,296	69,571	80,329	87,235	95,630	106,935	114,961	123,124	130,357	212,000
Commuter												
Weekly flights	63	70	77	84	91	98	105	112	119	126	133	166
Daily flights	9	10	11	12	13	14	15	16	17	18	19	24
Annual flights	3,285	3,650	4,015	4,380	4,745	5,110	5,475	5,840	6,205	6,570	6,935	8,651
Average seats	19.0	19.0	19.3	19.5	19.8	20.0	20.3	20.7	21.0	21.3	21.7	25.0
Annual seats	62,415	69,350	77,289	85,410	93,714	102,200	111,143	120,888	130,305	139,941	150,490	216,279
Load factor	32.0%	32.5%	33.0%	33.5%	34.0%	35.5%	35.0%	35.5%	36.0%	36.5%	38.0%	43.0%
Enplanements	19,973	22,539	25,505	28,612	31,863	36,281	38,900	42,915	46,910	51,078	57,186	93,000
Total enplanements	64,919	77,697	87,801	98,183	112,192	123,516	134,530	149,850	161,871	174,202	187,543	305,000
HIGH CASE												
Jet												
Weekly flights	15.5	19.0	22.5	26.0	29.5	33.0	36.5	40.0	43.5	47.0	50.5	83.0
Daily flights	2.2	2.7	3.2	3.7	4.2	4.7	5.2	5.7	6.2	6.7	7.2	11.81
Annual flights	808	991	1,173	1,356	1,538	1,721	1,903	2,086	2,268	2,451	2,635	4,312
Annual seats (@131)	105,876	129,784	153,691	177,599	201,506	225,414	249,321	273,229	297,136	321,044	345,224	564,912
Load factor	47.0%	47.5%	48.0%	48.5%	49.0%	49.5%	50.0%	50.5%	51.0%	51.5%	52.0%	57.0%
Enplanements	49,762	61,648	73,772	86,135	98,738	111,580	124,660	137,980	151,539	165,337	179,517	322,000
Commuter												
Weekly flights	63	91	119	147	175	198	231	259	287	315	336	439
Daily flights	9	13	17	21	25	28	33	37	41	45	48	63
Annual flights	3,285	4,745	6,205	7,665	9,125	10,324	12,045	13,505	14,965	16,425	17,520	22,884
Average seats	19.0	19.0	19.3	19.5	19.8	20.0	20.3	20.7	21.0	21.3	21.7	25.0
Annual seats	62,415	90,155	119,446	149,468	180,219	206,486	244,514	279,554	314,265	349,853	380,184	572,093
Load factor	32.0%	32.5%	33.0%	33.5%	34.0%	35.5%	35.0%	35.5%	36.0%	36.5%	38.0%	43.0%
Enplanements	19,973	29,300	39,417	50,072	61,274	73,302	85,580	99,242	113,136	127,697	144,470	246,000
Total enplanements	69,735	90,948	113,189	136,207	160,012	184,882	210,240	237,222	264,675	293,034	323,987	568,000
LOW CASE												
Jet												
Weekly flights	14	15	16	17	18	19	20	21	22	23	24	27
Daily flights	2.00	2.14	2.29	2.43	2.57	2.71	2.86	3.00	3.14	3.29	3.43	3.82
Annual flights	730	782	834	886	939	991	1,043	1,095	1,147	1,199	1,251	1,393
Annual seats (@131)	95,630	102,461	109,291	116,122	122,953	129,784	136,614	143,445	150,276	157,106	163,937	182,456
Load factor	47.0%	47.5%	48.0%	48.5%	49.0%	49.5%	50.0%	50.5%	51.0%	51.5%	52.0%	57.0%
Enplanements	44,946	48,669	52,460	56,319	60,247	64,243	68,307	72,440	76,640	80,910	85,247	104,000
Commuter												
Weekly flights	63	65	67	69	71	72	75	77	79	81	81	88
Daily flights	9.00	9.29	9.57	9.86	10.14	10.23	10.71	11.00	11.29	11.57	11.51	12.52
Annual flights	3,285	3,389	3,494	3,598	3,702	3,733	3,911	4,015	4,119	4,224	4,203	4,571
Average seats	19.0	19.0	19.3	19.5	19.8	20.0	20.3	20.7	21.0	21.3	21.7	23.0
Annual seats	62,415	64,396	67,251	70,158	73,117	74,689	79,388	83,111	86,505	89,962	91,199	105,128
Load factor	32.0%	32.5%	33.0%	33.5%	34.0%	35.5%	35.0%	35.5%	36.0%	36.5%	37.8%	39.0%
Enplanements	19,973	20,929	22,193	23,503	24,860	26,470	27,786	29,504	31,142	32,836	34,473	41,000
Total enplanements	64,919	69,598	74,653	79,822	85,107	90,713	96,093	101,944	107,782	113,746	119,720	145,000

Source: Leigh Fisher Associates, August 1995.